Wisconsin State Public Safety Communications System (WSPCS)
Functional Specifications

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1. INTRODUCTION

This document defines and details the minimum functional specifications for technical performance, quality, and reliability for the State of Wisconsin Public Safety Communications System (WPSCS). The WPSCS consists of a "System of Systems" linked by a backbone network of multi-dimensional redundancy. The requirements set forth here supplement the requirements for construction, operation and maintenance of the WPSCS that are set forth by the State Interoperability Executive Committee for the state of Wisconsin.

1.1. Wisconsin State Public Safety Communications System (WPSCS)

1.1.1. Objectives

The WPSCS system shall provide a statewide communications solution meeting the following operational objectives:

A. Statewide communications starting with voice and upgradeable to include high speed bi-directional multi-media data.
   1. A multi-agency land mobile radio (LMR) network accessible by state, county and local public-safety and public-service agencies, with availability for use by tribal and federal agencies
   2. Portable coverage throughout the system
   3. Individual agency autonomy.

B. Multi-vendor state-of-the-art feature-rich communications system
   1. Integrated Voice and Data
   2. At a minimum Project 25 compliance for interoperability at the subscriber level
   3. Digital trunked mode of operation
   4. Fault-tolerant backbone architecture,
   5. Secure Over-the-air programming (OTAP)
   6. Secure encrypted communications with over the air re-keying (OTAR) capability
   7. Uninterrupted roaming throughout the system when required and authorized
   8. Augmented radio coverage (by both extending the network as well as unit to unit coverage) through the use of vehicular repeaters, microwave linking, fiber optic networking, and satellite
   9. Direct radio-to-radio operation
   10. Seamless expandability to increase capacity and coverage based on trunking talk groups and hybrid multiband connectivity
   11. System deployed at 12.5 kHz, with system upgradeability to, or the equivalent of 6.25-kHz-per-voice-channel goal as future standards are defined and released.
   11. Interoperability
   1. Interoperability with all participating agencies
   2. Incorporation of mutual-aid channels on the bands used by the local system
   3. Compliance with Project 25 standards (ANSI/TIA/EIA-102 series) as required by FCC Rules in 47 C.F.R. 90.547 and 47 C.F.R. 90.548.

D. Mobile Data Networking
   1. Mobile data communications capability
   2. Access to database and network functions, both at the state/federal level and at the local IT department level.
   3. Automatic vehicle/radio location capable

4. Open-standard computer-aided dispatch (CAD) interface

E. Communications Backbone
   1. Provide high reliable, redundant communications between network sites
   2. Utilize microwave, fiber cable networking, and satellite as appropriate
   3. Provide for growth to support additional users, capacity, and functions
   4. Minimize capital cost to the all users while providing high redundancy and reliability through maximum use of available resources.

F. Frequency Plan
   1. Utilize frequencies currently licensed or available to public safety, only purchasing frequencies on the open market when absolutely necessary.
   2. Provide integration and control with fire paging system
   3. Formal statewide frequency plan must be created and maintained

1.1.2. Fundamental Requirements

A. Fundamental Requirements Specification
   1. Coverage
      Realizing there are physical barriers which may produce “dead spots”, the system shall provide portable coverage 95% of the time while being operated on the hip, outside of a structure, providing a minimum Delivered Audio Quality (DAQ) of 3.4 when operating in either analog or digital modes.
   2. Capacity
      a) Support at least 100,000 unique addresses.
      b) Support at least 5000 talk groups.
   3. Reliability
      a) 99.99% availability for the entire network.
      b) 99.999% availability for the network backbone.
   4. Expandability
      a) Ability to increase capacity as needed.
      b) Ability to increase coverage as needed.
   5. Security
      a) Support the use of U.S. encryption standards.
      b) Provide wireless access security.
      c) Provide physical radio access security
      d) Provide the ability to remotely remove a radio from the network.
   6. Interoperability
      a) Support the P25 common air interface for voice
      b) Support the data standards required by FCC 90.548.
      c) Support networking with legacy systems.
      d) Support the interlinking of Systems at the Console to Console level
   7. Network Management
      a) Monitor and control system resources and operational status
   8. Integrated voice and data on the system
   9. Digital Trunked System
   10. Provides unit-to-unit communication.
   11. Vehicular Repeater
      a) Extend system coverage for portable and in-building operation.
      b) Extend unit-to-unit coverage off the system.
   12. Spectrum efficiency ultimately equivalent to the 6.25 kHz per channel.
   13. Data throughput: A net error free data throughput of 6.0 kbps minimum in a 12.5 kHz channel bandwidth

1.1.3. Operational Concepts

A. Operation and Maintenance
   1. The technical operation of the backbone network is the responsibility of a designated state agency, also providing day-to-day operational control over the backbone network.
   2. There shall be a consolidated approach to backbone network management and maintenance.
   3. The designated state agency shall operate and provide management of backbone network technical facilities and maintenance control. Operational management of the use of the system (e.g. talk-group and encryption key assignments) will rest solely with the agencies using the system following predefined plan requirements.
   4. Operations of the network infrastructure are transparent to the user community.
   5. Some agencies that are expected to participate in WPSCS do not have internal resources with substantial communications ability; therefore, the designated state agency shall provide additional support for those agencies.

B. Expansion
   The WPSCS design shall be modular to permit: enhanced coverage for portable and in-building operation, and increased capacity as a result of increased number of units for currently participating agencies and for additional participating agencies as they come onto the system.

2. APPLICABLE DOCUMENTS

2.1. Compliance with Laws, Rules, Regulations, Codes, and Standards

A contractor and its subcontractors submitting RFP and RFQ documents or performing work shall be experienced in their respective field in the engineering, design, manufacture, installation, integration, operation, and maintenance of land mobile radio systems. They shall:

A. Comply with all applicable federal, state, and local laws, ordinances, codes, rules and regulations, and applicable industry codes and standards.

B. Obtain all technical references and specifications required to ensure compliance with the above.

2.2. Order of Precedence

In the event of a conflict between the text of the requirements in this functional specification, its appendices, and any references, the functional specifications and its appendices shall always take precedence over the references unless documented and agreed to by both parties prior to work taking place.

3. WPSCS SYSTEM REQUIREMENTS

A. WPSCS is a statewide wireless network that shall allow any County agency, or participating local, state or federal agency, to utilize a state-of-the-art voice and data radio communications system of systems.

B. WPSCS shall utilize a dedicated backbone to interconnect dispatch centers, base stations and other network components to provide high-reliability interoperable services to its users.

C. Basic benefits of the new system shall include:
   1. Wide-area portable in the street on the hip communications throughout the state.
   2. Interoperability among all participants — in accordance with their level of authorization,
   3. Interoperability with others using specified-designated interoperability/mutual aid channels as well as specifically designated talk groups.
   4. Networking systems to other systems by means of appropriate intra-system network interfaces.

D. The radio network shall provide public-safety and public-service agencies with communications solutions to serve the residents of the state of Wisconsin well into the twenty-first century.

3.1. General Requirements

3.1.1. Frequency Plan

A. WPSCS shall use frequencies available to public-safety users; such frequencies may be augmented, where necessary, with other frequencies which may have to be purchased on the open market.

B. All public-safety frequencies utilized by WPSCS shall be licensed to the agency responsible for the local systems or to the state as in the backbone network.
   1. These frequencies include, but are not limited to, the following bands:
      a) VHF 138 – 174 MHz Band
      b) 700 MHz band
      c) 800 MHz band
      d) 4.9 GHz band

C. WPSCS shall provide integration and control with the fire paging system and service on frequencies appropriate to the users.

D. The designated state agency shall work collaboratively with the participating agencies to ensure that the appropriate numbers of frequencies and communications channels are available.

3.1.2. Coverage

A. The basic network coverage design shall be applicable to vehicles, aircraft, railroad trains, and water vessels traveling at speeds up to 150 mph.

B. At least 95% of all test locations within the state shall meet or exceed the required coverage threshold for both voice and data.

C. The requirement for supplemental in-building portable coverage shall be defined for specific locations required by agencies; supplemental coverage requirements must be equal to or better than the statewide requirements.

D. Field use of portable radio equipment in the vicinity of a mobile unit may be facilitated by the optional use of vehicular repeater equipment.

E. Voice Coverage: Realizing there are physical barriers which may produce "dead spots", the system shall provide portable coverage 95% of the time while being operated on the hip, outside of a structure, providing a minimum Delivered Audio Quality (DAQ) of 3.4 when operating in either analog or digital modes. Coverage measured by using a mobile antenna, of unity gain, at a height of 1 meter above ground level — roughly equivalent to a passenger-car fender or trunk lid. This geographic area includes all urban, suburban, rural, and open areas, including navigable waterways.

F. Data Coverage: Realizing there are physical barriers which may produce "dead spots", the system shall provide portable coverage 95% of the time while being operated on the hip, outside of a structure, providing a net error free data throughput of 6.0 kbps minimum per channel. Coverage measured by using a mobile antenna, of unity gain, at a height of 1 meter above ground level — roughly equivalent to a passenger-car fender or trunk lid.

3.1.3. Capacity

A. WPSCS shall support at least 100,000 unique addresses. Addresses are used to identify any individual unit of subscriber equipment or managed infrastructure equipment within the state wide network (SWN).

B. SWN shall provide for at least 5,000 uniquely identifiable, functional talk groups.

C. The system architecture shall be scalable, without replacement, such that additional system loading (talk groups and subscriber equipment within an area) can be accommodated. Frequency planning must allow for additional trunked channels to be added to transmitter sites as required.

D. The system shall support all State agencies, County agencies, authorities and Fire Departments having wireless communication needs as well as Federal agencies and Tribal Nations.

E. Although its primary purpose is to provide communications capabilities for public safety agencies within the state, WPSCS will also support the operations of any county, local, state, or federal agency that endeavors to participate.

3.1.4. Interoperability

A. There are three general categories of subscriber unit interoperability. Any dispatch center can communicate on the interoperability portion of the network infrastructure:
   1. Unit-to-unit/talk group, direct and through the WPSCS system;
   2. Unit-to-unit between one system and another systems units operating in the same frequency band, direct and through the network.
   3. Unit-to-unit between one system and another systems units operating in frequency different bands using the network infrastructure.

B. To facilitate interoperability, the following Project 25 standards are required:
   1. Compliance with the ANSI 102 Common Air Interface to permit communication with other conventional or digital systems. Project 25 standards for intra and inter console communications, ISSI compliance must be applied to permit system to system communications.
   2. WPSCS interoperability digital channels require compliance with ANSI 102.BABA Vocoder Description and ANSI/TIA/EIA-102.AAAA DES Encryption Protocol, ANSI/TIA/EIA-102.AAAC DES Conformance Test and ANSI/TIA/EIA-102.AACA OTAR Protocol standards for end-to-end encryption, to permit efficient and secure gateway interface compatibility with other systems; along with compliance with other Project 25 (ANSI102) standards including the ISSI console communications standards.

C. All units within a given system are inherently interoperable because they are part of the same network. All WPSCS subscriber units shall be capable of ANSI 102 CAI operation with subscriber units provided from different manufacturers at minimum the following operations:
   1. Direct unit-to-unit or talk group,
   2. Unit-to-unit or talk group through a vehicular repeater
   3. Unit-to-unit or talk group through the Project 25 compliant infrastructure,
   4. Unit-to-unit or talk group through a vehicular repeater and infrastructure

D. In those areas where WPSCS operation is provided on 800-MHz or NPSPAC channels, compliance is required with the Regional Plans of FCC Public Safety Regions

E. Gateway interfaces shall be provided to permit automatic communication to and from each infrastructure-implemented interoperability channel and corresponding individual talk group.

F. WPSCS subscriber units shall utilize one or more standard CAI modes for interoperability with the infrastructure and other units of the WPSCS system on a unit-to-unit operation, and units of other systems on the FCC-designated interoperability (mutual aid) channels.

G. For communication with units outside of the WPSCS system ANSI/TIA/EIA 102.BAAA Common Air Interface — operating in a 12.5-kHz channel, using conventional mode and FDMA method, ANSI/TIA/EIA 102.BABA IMBE Vocoder description shall be provided for within the system.

3.1.5. Infrastructure Interoperability

A. WPSCS infrastructure shall be capable of providing gateways for inter-connecting with external radio systems.

B. The WPSCS shall be fully capable of providing gateways for full-featured (to the extent practicable) inter-connecting with other standardized systems and with the following manufacturers' proprietary (non-standards based) systems:
   1. MA-com,
   2. Ericsson,
   3. Motorola,
   4. Transcrypt-EF Johnson, and

5. Any other public-safety radio system operating in or adjacent to the state.
6. The WPSCS shall be fully capable of providing gateways for full-featured (to the extent practicable) inter-connecting with the following types of systems available from the manufacturers listed above:
   a) Digital,
   b) Analog,
   c) Trunked
   d) Conventional.

3.1.6. System Access Time

A. System hardware access time for all radios operating through WPSCS shall not exceed the following requirements:
   1. Unit to unit and unit to talk group (requires no infrastructure support). 250 msec
   2. Unit to unit and unit to talk group within a system (Intra-system) Involving a single system. 500 msec
   3. Unit to unit and unit to talk group through multiple systems (Inter-system) through the ISSI and infrastructure between multiple systems. 750 msec

3.1.7. Repeater Hang Time

Repeater hang time for message trunking and conventional channel operations shall be adjustable over a range of 0 to 6 seconds.

3.1.8. Effective Spectrum Efficiency

The bandwidth of all equipment shall comply with rules and regulations as specified by the FCC, and provide an eventual effective spectrum efficiency of and migrating to a 6.25 kHz per voice channel (except for the mutual-aid channels, which are 12.5 kHz per voice channel).

3.1.9. Grade of Service

A. A delayed call shall be considered to be any communication attempt not immediately establishing a talk-path. In this definition, “immediate” refers to time not exceeding the specified system access time limit (see subsection 3.1.6).

B. The delay time of a call shall be considered to be the length of time, beyond the specified system access time limit, that any communication attempt requires to establish a talk-path.

C. A blocked call shall be considered to be any communication attempt that fails to establish a Talk-path within a delay time of 3.0 seconds.

D. The daily busy hour for each site location shall be considered to be the busiest one-hour traffic period experienced over the course of a day.

E. All site locations shall have the ability to handle communications traffic at a Grade-of-Service level not to exceed 0.01. The Grade of Service for communications at each site location is defined as the daily busy-hour ratio of blocked calls to number of communication attempts.

3.1.10. Maintaining Communications Sites to High-Quality Standards

The participants shall maintain tower sites to the standards specified in the, Site Quality Standards

3.1.11. Availability

A. Fault Tolerance
   1. WPSCS shall have a fault-tolerant architecture that permits the radio system to continue operation in the event of a hardware or software malfunction.
   2. All WPSCS sites shall be capable of maintaining trunking operation if a site controller, control channel, and, or working channel fails, and if single infrastructure/backbone path fails.

B. Maintenance
   1. The requirement for provision of service is 7 days a week, 24 hours a day, including all holidays, within the time limit specified.
   2. Service Requirements: Service Severity Example of Situation Time to Respond Time to Repair
      a) Severity Level 1 (Catastrophic) - Total Loss of Communications or Functionality at a site or higher level. System Controller Failure. System (all or part) in "Site Trunking" Computer system is down. RESPONSE: 1 Hour to remotely interrogate problem, 2-4 Hours to respond on-site, except if exigent circumstances then 2 Hours
      b) Severity Level 2 (Major outage) - Loss of 25% of any System or Sub- System (no loss of communications). RESPONSE: 2-4 Hours to respond on-site, except if exigent circumstances then 2 Hours
      c) Severity Level 3 (System Impaired) - Loss of less than 25% of any System or Sub-System, Computer system operating on backup, Optimization Problem, Back-up Problem, Configurations Issues RESPONSE: 4 Hours
      d) Severity Level 4 (Work to be performed later) – Upgrades, Intermitted Problems – being monitored, Scheduled/Routine Maintenance. RESPONSE: 24 Hours
   3. In the event of a declared state of emergency, or by the request of the WPSCS office such as manhunts, riots, lost persons, severe weather events, disasters, or civil disturbances, etc., the above listed schedule will be suspended and the service provider shall respond to all requests for service in the affected area within two hours until such time as the situation is returned to normal.

C. Maintainability: Equipment shall include diagnostics that indicate failure to a replaceable-module level.

D. Hardware and Software Date Function
   1. Proper operation of all electronic equipment used in WPSCS shall not be affected in any manner by inability to process:
      a) Any date, and
      b) GPS end-of-week rollover.
   2. All current time and/or date functions shall be synchronized to a single time standard clock and automatically adjusted for Central Standard Time and Central Daylight Time.

3.1.12. Security

A. WPSCS is to be a public-safety, mission-critical communications system for a wide variety of federal, state, and local user-groups operating in life-and-death situations. As such, the continued, uninterrupted, uncompromised functioning of the system and its sites, facilities, and components is of paramount importance.
   1. The physical security of WPSCS and the information security of its traffic shall be provided at a level commensurate with that normally established for critical public-safety systems in today's criminal environment.
   2. The designated state agency shall be solely responsible for the safety and security of all WPSCS backbone sites, facilities, and components, (with the exception that node sites that are under the control and management of other municipalities or counties within the state) shall be afforded such security as may reasonably be effected, e.g. secure equipment enclosures within the space provided by such agencies.
   3. Failure of any component or portion of the network infrastructure due to inadequate physical and/or information security constitutes a failure, for which the protectorate shall be responsible.

B. Control of Network Access
   1. All personnel with direct access to WPSCS infrastructure and equipment that service, program, or support network operations shall be subject to a background investigation.
   2. All background information for personnel with direct access to WPSCS infrastructure and equipment shall be provided to the designated state agency for approval prior to allowing access.

C. Information Security
   1. WPSCS network shall be capable of operating with encryption that conforms to Federal Information Processing Standard (FIPS) Publication 46-3, Data Encryption Standard (DES) using Output Feedback (OFB) mode, or later NIST approved standards (e.g. AES) for use within the United States.
   2. Security Classification Levels 1, 2, 3, and 4 encryption standards shall be available to appropriately authorized users for secure end-to-end applications.
   3. The designated state agency shall provide DES, or other approved bulk encryption security over the network backbone.
   4. The system shall provide the following minimum security protection of the control signaling over the Air Interface (AI):
      a) Anti-alias,
      b) Anti-spoofing,
      c) Protection against unauthorized eavesdropping,
      d) Subscriber authentication, and
      e) Encrypted user and talk-group identities.
   5. There shall be a key-management utility available (with appropriate authorization), for use at any administrative level within the network, to maintain, distribute, and delete (in the case of lost or stolen) encryption keys, ensuring their integrity and confidentiality. This capability shall be exercisable by direct connection to terminal equipment or through Over-the-Air Re-keying (OTAR).

D. Physical Security
   1. Physical security of remote sites is a concern and shall include, but is not limited to, entry gates, perimeter fences with barbed wire, locks allowing service contractor, designated state agency and WPSCS personnel site access, concrete structures with steel door entryways, grilled or other wise access limited windows.

2. All components of site security shall be of suitable strength and design, and will reasonably withstand attempts to gain unauthorized access.
3. All sites shall contain intrusion detection and communications ability so as to inform the controlling agency of an intrusion in real time.

3.2. Subscriber Unit Requirements

3.2.1. Operational Mode

Except for certain conventional mode scenarios, WPSCS shall predominately operate in a trunked mode.

3.2.2. Connectivity

WPSCS will offer a wide range of connectivity features between radios to meet a wide range of communication needs.

A. System Call Options
   1. All units in the WPSCS system, within their function and range of authorization, shall have the ability to place the following system calls:
      a) Group,
      b) Individual,
      c) Dispatch,
      d) Local System-wide,
      e) Network-wide,
      f) Paging
      g) Emergency.
   2. The Group-call-type option shall permit a dispatcher or an individual subscriber unit, within its range of authorization, to call all units within a particular talk group.
   3. The Individual-call-type option shall permit a dispatcher or an individual subscriber unit, within its range of authorization, to call any other individual unit. (Private Call)
   4. The Dispatch-call-type option shall permit the dispatcher, within its range of authorization, to call:
      a) all units in any individual talk group,
      b) all units in multiple talk groups, or
      c) any individual unit.
   5. The System-wide-call-type option shall permit the system administrator to broadcast to all units within that physical system.
   6. The Network-wide-call-type option shall permit the network administrator to broadcast to all units in the entire network.
   7. The Paging-call-type option is an individual call type that shall permit a calling unit to send its ID to the display device of another unit.
   8. The Emergency-call-type option shall permit any unit to place an emergency call:
      a) at the highest level of priority,
      b) displaying the ID of the unit that invoked the emergency, and
      c) causing an intermittent, unique audible signal to be heard at all units other than at the one that invoked the emergency.

B. Knox Box Coverage

A Knox Box contains a master key that opens a safe on the side of a building. The safe contains keys for the building. When arriving at the scene, firefighters can

request that dispatch transmit a signal to open the Knox Box on the vehicle — enabling them to retrieve the key that will open the safe on the side of the building containing the keys needed to enter the building. The Knox Box safe can be opened by the proper DTMF signaling though base band audio from the radio.

C. Off-System Call Options

Based on the Capability Tier (subsection 3.2.4.A.), Subscriber units shall have the ability to place calls off the system (direct mode). It is understood that off-system call options are limited by the radio signal coverage of the units involved. Off-System Call Options:

1. Call Type Description
   a) Group: This option shall permit an individual WPSCS unit, within its range of authorization, to call all WPSCS units within a talk group.
   b) Individual: This option shall permit an individual WPSCS unit, within its range of authorization, to call any other individual WPSCS unit. (Private Call)
   c) Emergency: This option shall permit any WPSCS unit to place an emergency call displaying the ID of the unit that invoked the emergency, and causing a unique audible signal to be heard at all units other than at the one that invoked the emergency.

D. Radio System Organization
1. WPSCS shall employ a hierarchical structure for logical unit addressing.
2. WPSCS shall provide dynamic regrouping from an authorized control console (see subsection 3.2.3.A.2).

E. Telephone Interconnect
1. Any unit, within its range of authorization, shall be permitted to receive and place telephone calls from a subscriber unit through a Public Switched Telephone Network (PSTN) interface at the System level.
2. Any Network Operation Center shall be capable of permitting individual subscriber units to receive and place telephone calls (and of restricting them from doing so).
3. The Network Operation Center shall have the ability to override system restriction of telephone interconnect availability that shall be determined automatically by the amount of traffic loading present on the system.
4. Automatic echo-cancellation techniques shall be used where two-wire PSTN interfaces are present.

F. Dual-Tone Multi-Frequency (DTMF) Capability
1. All terminal units in the WPSCS system, based on Capability Tier (subsection 3.2.4.A), shall have the ability to transmit signals that will cause a standard dual-tone multi-frequency (DTMF) analog tone signal to be generated at the appropriate interface.
2. As the buttons on the DTMF tone pad are pressed, the corresponding tone signals shall be generated as a side-tone on the terminal device's speaker/earpiece. The side-tone level shall be adjustable by means of the volume control and by personality programming.

G. Access to External Network Services

WPSCS shall provide for each system a digital interface so that any terminal device, within its range of authorization, can access one or more external computer

networks. It shall be possible to manage subscriber units roaming out of one system, into another, and at the same time provide system-level diversity so that a single point of failure will not prevent the entire network from external computer network access.

H. FCC Mutual Aid Channels

WPSCS shall provide any terminal device, within its range of authorization, the capability to communicate with other units operating on FCC-designated interoperability mutual aid channels as provided in subsection 3.1.4.B.

I. Interoperability between Members
   1. WPSCS shall provide/allow interconnection with selected existing legacy systems that will allow for a period of time to replace the legacy systems with standards based systems.
   2. Within WPSCS, a set of common talk groups shall be set aside to provide interoperability among participating agencies. Terminal devices, within their range of authorization, shall be capable of operating on these common talk groups.

3.2.3. Services

The WPSCS radio system shall offer a wide range of functionality to support voice and data communications known as Services.

A. Radio Functions
   1. Radio Programming
      a) All radio personality programming shall be performed in accordance with the following methods:
         i. Local—All subscriber units shall be programmable through cable interface with an open-standard data port.
         ii. Remote—All subscriber units shall be programmable over the air from a remote location. (Over-The-Air Programming, OTAP.) This includes, but is not limited to:
         iii. Encryption keys (e.g. OTAR) and Talk-group assignments (e.g. Dynamic Regrouping).
      b) Radio personality programming shall include all technical parameters — including frequency, modulation, etc.
      c) Radio personality programming shall support all available features — including:
         i. Initial operating software,
         ii. Operating software upgrades,
         iii. Talk-group assignments,
         iv. Encryption keys, and
         v. Other radio-operating features according to the radio tier. (See Section 4)
      d) Subscriber unit programming shall be done over encrypted media to ensure protection from unauthorized sources.
      e) All data interfaces shall be supplied with an appropriate Application Program Interface (API) that can be supported by a third party.
      f) Programming capabilities shall include the ability to upgrade via software to features and capabilities not defined or present at the time of manufacture.
   2. Dynamic Regrouping

a) All subscriber units in the system shall have a dynamic regrouping feature that is programmable over the air for one or more new talk-group assignments.
b) Subscriber units shall have the capacity for a quantity of dynamically
c) regrouped talk groups based on Capability Tier. (See subsection 3.2.4.A)

3. Priority Assignments
   a) WPSCS shall provide for at least eight (8) levels of access priority that normally are assigned in unit personality programming.
   b) Emergency status shall be the highest priority.
   c) Optionally upon activation of a designated switch/pushbutton, an emergency status shall be transmitted immediately over the control channel to all units on that talk group, including control console(s), providing identification of the unit invoking the emergency.
   d) Optionally the unit initiating an emergency status shall receive a silent acknowledgement, displayed in a manner similar to other units, that its signal has been received.
   e) Optionally if the unit initiating an emergency status operates its Push-To-Talk (PTT) switch, that transmission shall be as immediate as possible, but in no case longer than being placed at the top of the queue for the next available channel assignment.
   f) I installed the “person-down” feature shall cause emergency status warning to be activated.
   g) A recent user shall have a one-step-higher priority over its normal priority during a programmable interval following the previous transmission of that talk group to permit communication continuity, but in no case as high as an emergency-status priority.
   h) Under heavy-loading conditions, upon initiation of emergency status by a subscriber unit, the system shall be capable of pre-empting the lowest-priority user, providing an appropriate warning tone to indicate the communication was system terminated.
   i) The system shall have the capability to assign talk-groups to a higher priority level during emergency situations.
   j) The system shall have the ability to assign a priority level to individual subscriber in a talk-group.
4. User-Configurable Functions
   WPSCS voice communication subscriber units, based on Capability Tier (subsection 3.2.4.A), shall (through radio system programming software) provide the capability to adjust or preset certain features, levels, and characteristics, including:
   a) Display characteristics (brightness, contrast, etc.),
   b) Audio output levels,
   c) Trunking Talk Group/Conventional Channel selection,
   d) Programmable function keys, and
   e) Control protocols and signaling.
5. Selective Radio Inhibit
   a) System administrator terminals shall have the ability to enable or disable the transmit and/or receive functions of any subscriber unit.
   b) A system administrator terminal shall have the ability to assign that subscriber unit to a unique talk group and activate ambience listening. Ambience listening is defined as the ability of a system administrator terminal to place the subscriber unit into transmit mode without the subscriber’s knowledge. This feature may be used when the unit is lost or stolen.
6. Voice and Data Encryption

Based on Capability Tier (subsection 3.2.4.A), an encrypted terminal shall have the capability to be loaded for at least sixteen (16) different encryption keys.

B. Voice
   1. The following requirements are applicable to the transmission of voice communications through the WPSCS digital network.
      a) Modes
      b) As a minimum, all terminal units shall be capable of operating in:
      c) Simplex, and
      d) Half-duplex.
   2. High-tier subscriber units shall be capable of operating in full-duplex mode, with appropriate echo canceling.
   3. Vocoder
      a) A voice coder/decoder (Vocoder) shall be used in any interface to other analog voice networks, or as a transcoder in a gateway to another digital radio network employing a different Vocoder technique.
      b) The Vocoder shall comply with the standards specified in subsections 3.1.4.B.2 and 3.1.4.G, as described and evaluated in the following standards:
         i. ANSI 102.BABA,
         ii. ANSI 102.BABB, and
         iii. ANSI 102.BABC.
   4. Delivered Audio Quality
      The system voice performance shall be no less than a DAQ of 3.4 over the 97% area coverage required throughout the state under all weather and foliage conditions. The description of DAQ is provided in TIA-TSB 88A

C. Data
   This section includes requirements specific to the communication of data throughout the network.
   1. Data Types
      WPSCS shall be capable of supporting applications that transmit and receive various forms of data content, including but not limited to:
      a) Short Messaging (e.g. up to 254 bytes),
      b) Text and American Standard Code for Information Interchange (ASCII) data,
      c) Image and Graphics (e.g. JPEG files),
      d) Binary files (e.g. MP-3 files), and
      e) Video (e.g. from streaming to full motion).
   2. Data Transfer
      The data types listed in subsection 3.2.3.C.1 shall be supported for the following transfer modes in both conventional and trunked operation:
      a) Radio-to-radio
         i. Radio-to-many-radios
         ii. Radio-to-dispatcher
         iii. Dispatcher-to-radio
         iv. Dispatcher-to-many-radios.
      b) Data Spectral Efficiency
         i. Net data-throughput efficiency shall be defined as the actual number of bits per second per Hertz of channel width transferred, excluding overhead/control, forward error correction, and retransmission.
         ii. Net data throughput efficiency shall be at least 0.576 bits per second per Hertz of channel width.

3.2.4. Subscriber Unit Requirements

This section presents hardware and software specifications for all mobile, portable, and control station radio equipment to be used in WPSCS. The WPSCS shall be comprised a system of systems, each having multiple tiers of equipment and services available to end-users.

A. Subscriber Unit Tiers
WPSCS shall be designed to accommodate the features and functionality required by at least the three tiers of subscriber equipment described below.
1. Portable Unit Features
   a) Tier I Portable Radio features shall include:
      i. Volume Control,
      ii. Talk-Group/Channel Selector,
      iii. Push-to-talk,
      iv. Remote microphone/speaker connector, and
      v. Ability to monitor channel.
   b) Tier II Portable Radio features shall include:
      i. Tier I Portable Radio features,
      ii. Display,
      iii. Encryption capability,
      iv. As many as four Programmable Keys,
      v. Industry-standard data interface,
      vi. Receiving paging calls, and
      vii. Private unit-to-unit calling.
   c) Tier III Portable Radio features shall include:
      i. Tier II Portable Radio features,
      ii. Remote antenna connector, and
      iii. Alphanumeric keypad that supports Telephone Interconnect and DTMF. The keypad shall be a typical 16-button configuration to achieve the full DTMF capability.
   d) There may be an option for a “pull-pin” type emergency (“man-down”) feature for all three tiers of portable radios.
2. Mobile Unit Features
   a) Tier I Mobile Radio features shall include:
      i. Volume Control,
      ii. Talk-Group/Channel Selector,
      iii. Push-to-talk,
      iv. Auxiliary microphone/speaker connector,
      v. Industry-standard data interface, and
      vi. Ability to monitor channel.
   b) Tier II Mobile Radio features shall include:
      i. Tier I Mobile Radio features,
      ii. Display,
      iii. Automatic Vehicle Locator (AVL) capability,
      iv. Global Positioning System (GPS) capability,
      v. Encryption capability, and
      vi. Telephone Interconnect capability with limited pre-programmed dialing.
   c) Tier III Mobile Radio features shall include:
      i. Tier II Mobile Radio features,
      ii. Alphanumeric keypad that supports Telephone Interconnect and DTMF. The keypad shall be a typical 16-button configuration to achieve the full DTMF capability,
      iii. Receipt of paging calls, and

iv. Private unit-to-unit calling. Also see subsection 3.2.4.C.2.

d) There shall be an option for a mobile subscriber unit to operate on a battery system separate from the vehicle's ignition system. This requirement is intended to support operations in remote areas for extended periods of time. The intention is to ensure that the radio does not degrade the ability of the automobile battery to start the engine.

B. General Requirements

1. Environment
   All subscriber units shall be designed to meet or exceed MIL-STD-810 C/D/E.
2. Antennas
   a) Antennas for Portable Radios
      i. The antenna shall have a gain of 6 dBd (decibels relative to a dipole) or higher.
      ii. The antenna shall be included with the unit.
      iii. The antenna shall be field replaceable, without tools.
      iv. Where appropriate, the attached speaker-microphone, or attached handheld microphone, may incorporate the antenna.
   b) Antennas for Mobile Radios
      i. Fixed-mount antennas shall be supplied for a variety of installation types, including vehicles, aircraft, railroad trains, and water vessels.
      ii. Optionally, a magnetic-mount antenna shall be provided for applications that require such an antenna as a temporary installation.
   c) Antennas for Vehicular Repeaters
      i. Fixed-mount antennas shall be supplied for a variety of installation types, including vehicles, aircraft, railroad trains, and water vessels.
      ii. Optionally, a magnetic-mount antenna shall be provided for applications that require such an antenna. (Magnetic mount antennas shall be considered usable only in a temporary application)
   d) Control Point Antennas
      Antennas shall comply with FCC and FAA regulations for fixed-site antennas.
3. RF Radiation Hazard Safety
   a) To ensure human safety around fixed-site antennas, EMR safety requirements shall be followed, as listed in:
      i. 47 CFR 1.1310 "Radio Frequency Radiation Exposure Limits,"
      ii. 47 CFR 1.1307 "Actions that may have a significant environmental effect, for which Environmental Assessments must be prepared," and
      iii. ANSI/IEEE C95.1.
   b) To ensure human safety around mobile and portable terminal device antennas, EMR safety requirements shall be followed, as listed in:
      i. 47 CFR 1.1310 "Radio Frequency Radiation Exposure Limits,"
      ii. 47 CFR 2.1091 "Radio Frequency Radiation Exposure Evaluation: Mobile Devices,"
      iii. 47 CFR 2.1093 "Radio Frequency Radiation Exposure Evaluation: Portable Devices," and
      iv. ANSI/IEEE C95.1.

C. Tier III Subscriber Unit Features

1. Tier III Portable Subscriber Equipment Requirements
   a) Physical
      Portable units shall withstand TIA/EIA-603, "Land Mobile FM or PM Communications Equipment Measurement and Performance Standards," February 1993 — with TIA/EIA-603-1 "Addendum 1," March 1998, paragraph

5.3.5, “Shock Stability.” This test requires the portable unit with battery installed to be dropped on each of its six sides from a height of 100 centimeters (one meter) onto a smooth concrete floor, following which, the unit shall maintain specified mechanical and electrical performance suffering only superficial mechanical damage.

b) Operating features
Tier II portables shall have the following operating features:
   i. Low battery indicator,
   ii. Call-book memories (phone numbers, etc.),
   iii. Paging and Private calling.

c) Visual Display
Tier III Portable subscriber units shall have the following visual display features:
   i. Back-lit display visible in bright sunlight,
   ii. Readable in direct sunlight,
   iii. Readable in darkness,
   iv. Display brightness (for nighttime use) as an operator-adjustable feature, and
   v. Ability to fully dim display.

d) Knobs
If applicable, Tier III Portable subscriber units shall have the following knob features:
   i. Made of a non-slip material, and
   ii. Detent control to provide tactile feedback.

e) Keypads
Tier III Portable subscriber units shall have the following keypad features:
   i. Made of a non-slip material,
   ii. Provide tactile feedback,
   iii. Arranged so as to prevent accidental operation,
   iv. Clearly labeled,
   v. Clearly visible,
   vi. Back-lit labels for nighttime use
   vii. The ability to emit an audible signal each time a key is pressed.

f) Audio Output
The audio output power of Tier III portable subscriber units shall be at least 500-milliwatts.

g) Device Interfaces
Data Input device interfaces shall be RS-232 or Universal Serial Bus (USB).

h) Antenna
Tier III portable units shall have a detachable unity-gain antenna.

i) Hand-held microphone
Tier III Portable subscriber units shall have, as an option, the following hand-held microphone features:
   i. Programmable function keys,
   ii. DTMF keypad,
   iii. Noise canceling, and
   iv. Lapel clip.

j) Speaker microphone
Tier III Portable subscriber units shall have, as an option, the following hand-held speaker-microphone features:
   i. Programmable function keys,
   ii. DTMF keypad,
   iii. Noise canceling,

iv. Built in speaker with earpiece jack, and
v. Lapel clip.

k) Battery
i. Battery operation time shall be no less than 8 hours at 5% Transmit, 5% Receive, and 90% standby.
ii. Extended Battery operation time, beyond the minimum 8 hours, shall be accomplished through such techniques as transmitter-power management.

l) Battery Charger
Battery chargers for Tier III Portable subscriber units shall have the following features:
i. Drop in charger,
ii. Capable of charging portable subscriber batteries to full capacity within 60 minutes,
iii. Auto-shut-off feature that stops charging the battery when it has reached full charge
iv. Available with an integrated capacity-testing feature.
v. Battery chargers powered from 120 VAC 60 Hz for Tier III Portable subscriber units shall be available in single and multi-unit chargers, and
vi. Single unit vehicular chargers powered from vehicle DC for Tier III Portable subscriber units shall be available.

2. Tier III Mobiles
a) Operating features
Tier III mobile subscriber units shall have the following operating features:
i. Nonvolatile user programmable memories (phone numbers, etc.),
ii. Paging, and
iii. Private calling.

b) Visual Display
Tier III mobile subscriber units shall have the following visual-display features:
i. Back-lit display, which shall be visible in bright sunlight,
ii. Readable in direct sunlight,
iii. Readable in darkness,
iv. Display brightness (for nighttime use) as an operator-adjustable feature, and
v. Ability to fully dim display.

c) Knobs
If applicable, Tier III mobile subscriber units shall have the following knob features:
i. Made of a non-slip material, and
ii. Detent control to provide tactile feedback.

d) Keypads
Tier III mobile subscriber units shall have the following keypad features:
i. Made of a non-slip material,
ii. Provide tactile feedback,
iii. Clearly labeled,
iv. Clearly visible,
v. Back-lit labels for nighttime use, and
vi. The ability to emit an audible signal each time a key is pressed.

e) Audio Output
Tier III mobile subscriber units shall have the following audio power output features:
i. 5-watt peak audio power output standard, and

ii. 10-watt peak audio power output optional.

f) Auxiliary Speaker
Tier III mobile subscriber units shall have the following auxiliary speaker features:
i. Amplified to produce 25-watt peak audio power output, and
ii. Provided with a mating connector set.

g) Hand-held Microphone
A hand-held microphone shall be included with all mobile radios, with a connector to permit ease of removal and replacement.

h) Auxiliary Microphone
An auxiliary microphone shall be available as an option for Tier III mobile subscriber units with the same features as the microphone normally supplied with each mobile subscriber unit, including the connector, for interchangeability and ease of maintenance.

i) Auxiliary Weatherproof Microphone
An auxiliary weatherproof microphone shall be available as an option for Tier III mobile subscriber units; otherwise, with the same features as the microphone normally supplied with each mobile subscriber unit, including the connector, for interchangeability and ease of maintenance.

j) Power Supply
All subscriber units shall operate with 12-VDC negative ground, and a power converter shall be provided for any other type of power that may be required on vehicles, aircraft, trains, or vessels.

k) Device Interfaces
Data Input device and computer interfaces shall be RS-232 or Universal Serial Bus (USB).

3. Vehicular Repeater
   a) As an optional feature of Tier III mobile subscriber units, a vehicular repeater function shall be provided.
   b) The vehicular repeater system may operate in the same frequency band and use the same antenna as the mobile subscriber function.
   c) The vehicular repeater system shall operate from 12-VDC negative ground power, and a power converter shall be provided for any other type of power that may be required on vehicles, aircraft, trains, or vessels.
   d) An optional 120-VAC, 60-Hz power supply shall be available for portable tactical applications.
   e) Operation of multiple vehicular repeaters within close proximity shall be possible. Such operations may utilize the same talk-group or different talk-groups.
4. Control Stations
   A Control Station is commonly known as a control point under FCC rules.
   a) A Control Station unit shall consist of a single subscriber unit, typically a mobile unit, packaged in a desktop enclosure, equipped and configured to operate at a fixed location.
   b) All Control Station units shall require a 120-VAC power supply with a current load capacity at least 50% greater than the maximum required by the radio during transmit.
   c) The power supply shall include provision for a standby battery with the following features:
      i. The power supply shall incorporate an appropriate voltage-limited charger designed for the battery type installed with the unit,

ii. The standby battery capacity shall be selectable according to the number of hours of operation of the Control Station at a 35% transmit, 35% receive and 30% standby duty cycle operation, and
iii. The standby battery, protective enclosure, and power cables shall be provided as an available option.

5. Portable Vehicular Charger Adapter
   There shall be an option to provide for a vehicular charger adapter unit with the following features:
   a) The vehicular charger adapter will permit the use of a portable radio as a mobile with a microphone, speaker, and antenna similar to a Tier III mobile subscriber unit.
   b) An RF amplifier shall be provided as an option to increase transmitter power output to a level equivalent to Type III mobile transmitters.
   c) The performance parameters shall be the same as the applicable portable and mobile components.
   d) The portable vehicular charger adapter shall operate from 12-VDC negative-ground power, and a power converter shall be provided for any other type of power that may be required on vehicles, aircraft, trains, or vessels.
6. Interfacing to Peripheral Devices
   a) To provide the highest degree of functionality, portable and mobile terminal equipment shall have the capability to interface with independent peripheral devices through use of the standard interfaces available on their radios.
   b) Examples of peripheral devices are:
   Mobile Computer Terminals, Printers, Facsimile, Image Scanner, Finger Print Scanner, Bar Code Reader, Card Reading Device, and Digital Camera.

D. Automatic Vehicle Location (AVL) Requirements
1. At a minimum, AVL shall be offered as an option for Tier III portables and mobiles.
2. The AVL option will be powered from its associated subscriber unit.
3. The AVL system shall have the capability to track and locate individual units to within a five meter radius.
4. The AVL system shall be integrated within the terminal equipment.
5. Subscriber units shall transmit AVL data upon direct command or at programmable intervals, consistent with not causing excessive loading of the system.
6. The AVL may be linked to the emergency/"man down" feature to transmit location data, simultaneously denoting it with an alert message.

3.3. Dispatch Center Facility Operational Equipment

3.3.1. Planning Process and Checklist

A. Standards are being developed and released which will significantly effect the operation of future dispatch consoles and the equipment installed with them. The core of the networking will take place within the switches and routers attached to the Dispatch consoles. Care must be taken to insure that upgrades and replacement planning of the equipment involved complies with the minimum standards required to support P25 ISSI networking as progress is made toward a IP based console to console interoperable system.

3.3.2. Consoles

A. Consoles shall have an ergonomic and efficient layout of all components.

B. A console position shall include but not limited t
   1. displays,
   2. keyboards,
   3. pointing devices,
   4. computers,
   5. two operator headset jack boxes/panels (main and supervisory) with individual receive audio volume control for each console position,
   6. Network interface, both to the local data base and to the state wide network conforming to the specifications as defined in the ISSI P25 standards.
   7. telephone terminal equipment,
   8. selection, adjustment, and operation of all console features — in accordance with the operator's level of authorization,
   9. console time that is synchronous with the Network time standard, based on GPS
   10. network management software, and
   11. dispatch software.

C. The dispatch console shall provide audio amplification and allow the operator to direct audio to different speakers. Each dispatch console position shall be capable of monitoring multiple events with individual speakers — selected audio, unselected audio, and separate operator-selectable sources.

D. The console shall be capable of answering and originating telephone calls from:
   1. Telecommunications Device for the Deaf (TDD) communications, including the automatic recognition of ASCII and Baudot signaling,
   2. Integrated Services Digital Network (ISDN),
   3. PSTN,
   4. Private line, including automatic ring-down signaling systems, and
   5. Optional 911 trunks.

E. Other features that shall be provided by the console, according to the operator's level of authority, include:
   1. monitoring closed-circuit television,
   2. paging,
   3. monitoring alarm systems, and
   4. operation of remote-control/access systems.

3.3.3. Communications Logging Recorder

A. A digital multi-channel recorder shall be incorporated into the Dispatch Center for the purposes of logging all:
   1. Radio transmissions on the system, by physical radio channel, with unit-ID and trunking talk-group identification derived from the radio channel signaling,
   2. Telephone calls, both lines and instruments
   3. Console transmit and selected audio, console unselected audio, and console intercom audio.

B. The voice-recording system shall be capable of recording telephone calls from:
   1. Telecommunications Device for the Deaf (TDD) communications, including the automatic recognition of ASCII and Baudot signaling,
   2. Integrated Services Digital Network (ISDN),
   3. PSTN lines,
   4. Private line, and

5. 911 Trunk lines.

C. The voice-recording system shall have the following capabilities:
   1. Utilize COTS optical or electronic storage methods in a fault-tolerant design,
   2. Provide multiple indices for each recorded communication, including:
      a) Time,
      b) Date,
      c) Storage location,
      d) Radio identification; or telephone number of distant party (ANI),
      e) Talk group, if trunked; channel, if conventional (for radio communications); or telephone subscriber name,
      f) Location of radio unit (if AVL equipped); or address of distant party telephone number (ALI),
      g) Telephone line identification (for telephone communications),
      h) Console identification for console operator and loudspeaker record channels, and
      i) Miscellaneous field for operator remarks,
   3. Time and date synchronous with the Network time standard,
   4. Provide at least 500 channel-hours of recorded audio per individual storage unit, with multiple storage units to facilitate automatic transfer when the recording medium reaches its capacity.
   5. Provide direct access to any indexed location on the storage unit,
   6. Provide volume header information to uniquely define the storage unit, including:
      a) Unique volume identifier,
      b) Volume label,
      c) Protection period of recorded information,
      d) Initial record date,
      e) End record date,
      f) Recorder identification, and
      g) Index table of information recorded.
   7. Dubbing output connector,
   8. Head phone connector,
   9. Interface with CAD system, and
   10. Standard computer interface to access the information.
   11. Provide indexed trunking tracking with the radio system for playback

3.3.4. Instant Recall Recorder

A. The Instant Recall Recorder (IRR) function can be an adjunct of either the console system or the logging recorder system, to separately record the current conversation in which the operator is engaged.

B. Control of the IRR shall be incorporated into each dispatch console system.

C. The IRR shall record radio transmissions (transmit audio and selected receive audio) and telephone calls (telephone instrument).

D. The IRR shall be a digital recorder using electronic storage methods in a fault-tolerant design capable of storing 30 channel-minutes of audio.

E. Each recording made shall be time stamped — time synchronous with the network time standard.

F. The IRR shall also have an RS-232, or similar open-standard interface, built into the console.

G. The IRR shall also provide a headphone connector and front-panel search/scan controls.

3.3.5. Computer-Aided Dispatch (CAD)

A CAD system is an integrated database software feature of a modern communications system that efficiently provides situational data for the command and control of agency resources. The WPSCS systems shall have CAD capability, interfaced so that it can be networked to provide redundancy for fault tolerance, and peak load sharing operation. Typically, a CAD system is integrated into a dispatch console, which provides control of a variety of components and features according to its level of authorization (e.g. a terminal unit, system administration terminal, data communications terminal, telephone interface control).

A. CAD systems shall be available to each system within the network.

B. The CAD systems shall be capable of supporting all public-safety and public-service agencies operating on WPSCS.

C. Any CAD system located within the network shall be capable of being transferred to a backup Dispatch Center or its operations transferred to an Alternate Dispatch Center.

D. Where appropriate, and when available, open-standard interfaces shall be used.

E. CAD Software Requirements: CAD system shall have or be able to perform the following:
   1. Graphical user interface (GUI),
   2. Keyboard and pointing device,
   3. Where available, Automatic Number Identification (ANI) and Automatic Location Identification (ALI) of all incoming calls (e.g. E-911, Wireless-911, PSTN Caller-ID, radio unit-ID, and Talk-group-ID),
   4. Display on a Map the ALI and unit tracking of any subscriber unit,
   5. Unit operational status (e.g. emergency, available, enroute, maintenance, etc.),
   6. Visual and audible alarms for unit emergencies,
   7. Integrated GIS database management capable of query and display of spatial data (e.g. ArcInfo, MapInfo), custom mapping displays, and real-time unit routing (e.g. alternate routing to bypass construction areas, congestion, and other traffic delays),
   8. Utilization of available Intelligent Transportation System (ITS) data (e.g. accident notification by means of traffic-flow alarms),
   9. Time entries to be actual event time; current time to be synchronous with the network time standard,
   10. According to level of authorization, access to criminal records and databases
   11. Records management (including logging all events with date-and-time stamps),
   12. Periodic generation of records-management reports,
   13. Transfer of information between terminals (e.g. incident reports from call taker to radio dispatcher),
   14. Dispatch and Incident report generation,
   15. Scheduling and shift management,

16. Provide dispatch support,
17. Electronically capture, save, and print data from terminal units, and
18. Availability of a second port for simultaneous video display from individual terminal units. There will be situations in which dispatch and network management will be performed at the same physical location. Therefore, it is desired that CAD functionality and network management functionality be integrated on a common network. Integration could be achieved through the application of multiple display windows on a single terminal device or through multiple display terminals.

F. CAD Hardware Systems
CAD hardware systems shall be redundant and provide fault-tolerant, mirrored backup protection.

G. Online Help
1. All CAD software shall provide the dispatcher with on-line help that is:
   a) Comprehensive,
   b) Indexed, and
   c) Easily accessible, without off-site network access.
2. Supplemental technical support shall be accessible from the vendor's Internet site or by toll-free telephone access to the vendor's 24-hour central support center.

H. Multi-Agency Support
1. The CAD software shall support more than one agency on a single system.
2. The CAD software shall be capable of dynamic assignment of an agency's resources from one CAD system to another.

I. CAD System Security
All CAD systems shall incorporate user authentication and control to limit access of users to appropriate levels of functionality and data.

J. CAD System Capacity
The CAD system shall have sufficient resource capacity to accommodate the worst-case loading requirements of each WPSCS participating agency within the WPSCS system.

3.4. Infrastructure Requirements

All fixed equipment up to the air interface is considered to be part of the infrastructure. For example:

A. Site
1. Shelter,
2. Antenna systems (filters, combiners, antennas, transmission lines, connectors, etc.),
3. Fencing,
4. Grounding,
5. Tower,
6. Power,
7. Back-up Power,
8. Land-Mobile Base Station,
9. Microwave Radio,

10. Fiber-Optic Cable,
11. Telephone Cable,
12. Alarm system,
13. Fire Protection,
14. Environmental Control Systems (HVAC),
15. Stone or paved Surfacing,
16. Drainage,
17. Concrete Footings and Foundations, and
18. Ice Protection.

B. System Control
   1. Switch,
   2. Receiver Voting Equipment, and
   3. Network Control and Console.

3.4.1. Communication Types

A. The designated state agency shall consider the following types of backbone network interconnection in descending order of preference:
   1. Point-to-Point Microwave,
   2. Dedicated Fiber-Optic Cable,
   3. Leased Fiber-Optic Cable,
   4. Dedicated Telephone Circuits,
   5. Leased Telephone Circuits,
   6. Dedicated Satellite (e.g. Dedicated Transponder Channel with backup), and
   7. Leased Satellite Service.

B. Point-to-Point Microwave
   These requirements are to be applied to those portions of the network backbone in which point-to-point microwave is utilized
   1. Point-to-point microwave shall operate in a frequency band appropriate to the application for the system requirements (e.g. bandwidth, climatic conditions).
   2. The designated state agency shall be responsible for:
      a) Designing and engineering the microwave backbone
      b) Selection of transmission lines and antennas.
      c) Necessary mounting hardware (and items in support of them).
      d) Where required, frequency coordination and preparation of the applications in the name of the State of Wisconsin.
      e) Compliance with all FCC and FAA requirements for new and existing tower structures used in the microwave backbone.
   3. The location of the microwave backbone shall be based on the land-mobile radio system and console interconnect site requirements.
   4. When necessary, if a line-of-sight link does not exist between two existing radio station locations, an alternate path shall be chosen, which may include another site acting as an intermediary location.
   5. All tower sites shall adhere to the guidelines identified by a designated state agency Site Quality Standards document.
   6. The designated state agency shall reserve the right to accept or reject approval of all prospective sites to be chosen for locating microwave relay infrastructure.
   7. The radio-modulation format shall be digital and the scheme selected shall achieve specified error performance and availability objectives within the authorized bandwidth of the operating frequency band.

8. Microwave radio equipment shall have hot-standby transmitters, either hot-standby or space diversity receivers that provide errorless switching, and contain an order-wire channel as well as offload logic and hardware to interconnect to optical fiber when necessary. It is a design objective that medium- and high-capacity digital microwave radios shall employ adaptive time-domain equalization.
9. Microwave parabolic antennas shall contain shrouds to minimize side-lobe radiation and shall have weather-resistant radomes bolted to the reflector for maximum survivability.
10. Microwave waveguides shall be a continuous run without splices, be pressurized, use dehydrators to remove moisture, and be bonded to the tower at the vicinity of the antenna mounting, to the tower at the bottom of the vertical run, and at the grounded bulkhead panel entry into the equipment shelter.
11. The designated state agency shall design the digital multiplex and cross connect subsystems to permit proper communications channel routing between WPSCS land-mobile radio sites.
12. The microwave system shall have an alternate-control center.
13. Patch-panel access to the radio base band interface shall be provided on each hop to permit future installation of a National Institute of Standards and Technology approved Data Encryption Standard or Advanced Encryption Standard link-encryption device.

C. Owned Fiber-Optic Cable or Telephone Circuits
1. The cable used shall be ruggedized to withstand deployment commensurate with the climate, soil conditions and environment of Wisconsin weather. Fiber-optic cable may be deployed above or below ground. Telephone circuits shall enter the site underground.
2. The designated state agency shall survey, engineer, and construct cable lines, as required.
3. The designated state agency shall procure all required permits, permissions, and rights of way, where applicable.

D. Leased Fiber-Optic Cable or Telephone Circuits
If access to, or development of new, State-owned or dedicated microwave, fiber, or telephone circuits is not possible, leased data lines may be used to provide the same degree of capacity and availability.

3.4.2. Backbone Communication Reliability

A. Radio Equipment Switching Time. The time to detect a transmission fault, switch to the alternate transmitter or receiver, and permit the system to recover shall not exceed 50 milliseconds.

B. Availability Objective. The one-way, end-to-end DS1 cumulative severe error seconds outage shall not exceed 0.001% per year.

C. These services shall have a bit-error-rate less than 10 to the -10 after error correction during the period of availability.

D. Error Performance Objective. The one-way, end-to-end DS1 cumulative error seconds shall not exceed 0.005% per any month.

E. Backbone transceivers and interconnects shall have protection against surges, electromagnetic interference (EMI), and lightning.

3.4.3. Fault-Tolerant Architecture

A. WPSCS' backbone shall have a fault-tolerant architecture that permits the system to continue to operate in the event of a primary link failure.

B. The backbone shall have redundant paths interconnecting sites that allow data to be re-routed automatically if a path in the main link should fail.

3.4.4. System Interfaces

All interfaces — including protocols (e.g. message definitions) and physical connections — to any system shall be open standard and non-proprietary and comply with the minimum requirements of the APCO P25 specifications for subsystem and inter system communications standards.

3.4.5. Remote-Diagnostic Capability

A. Diagnostics shall be automatically reported to the Network Operation Center.

B. The Network Operation Center(s) shall be capable of interrogating system components for status.

C. Access shall be provided from any site to perform diagnostics on equipment located at that site and at any other site in the same System.

D. The diagnostics information shall also be accessible via network or telephone access through a secure dial-back modem from a remote location for servicing purposes.

E. When any portion of the WPSCS backbone experiences a malfunction, a status alert shall be sent to the designated state agency control center over the backbone.

3.4.6. GPS Time Synchronization of WPSCS Backbone

A. At every site where an external time synchronization reference is required, the station clock shall be derived from GPS.

B. The station clock shall be at least Stratum 2 stability.

3.4.7. Remote Capability

Every base station used in WPSCS shall be capable of being controlled and programmed from the Dispatch Center of its home system.